TO WHAT EXTENT DOES EINSTEIN MODIFY NEWTON?

by

Diane Shaver Clemens

Interesting resolution of the matter. Agreement; could use a copy of your draft.

The primary aim of science through the ages has been to explain the world in which we live. Aristotle in the fourth century before Christ began by asking <u>why</u> things happen. Modern science arose when in the seventeenth century Galileo, followed by Newton, originated methods of controlled experiment and sought an answer to the question <u>how</u> things happen.

Newton created through his science a mechanical universe of forces, pressures, tensions, waves, and oscillations. These he described in accurate mechanical laws which led men to view the universe as a smoothly functioning mechanical universe, the reality of which could be described in terms of ordinary experience illustrated by a concrete model. RP

Causality and determination ~~were~~ became two assumptions basic to the scientific and philosophical viewpoint as a result of Newton. Yet by the beginning of the twentieth century, the edifice of the old science began to tumble, altered by slight deviations from Newton, but deviations whose consequences were sufficiently far-reaching to change the whole structure of science.

The science of the twentieth century has demonstrated the truth of a number of necessary changes from Newtonian physics. No longer is the ordinary world of experience or sense perception adequate to describe nature. Rather the world of man's senses is a world of inaccuracies. The certainty that science would be able to explain <u>how</u> things happened was abandoned. Further, by utilizing statistics

and probabilities science abandoned all idea that nature exhibits an inexorable sequence of cause and effect. And with its emphasis upon uncertainty, the hope of forecasting the history of the universe on the basic of determinates was lost.

The extent to which the Relativity theories of Einstein altered Newtonian physics can best be seen by examining the particular theories. In all cases, the findings of Einstein did not contradict classical physics, but simply regarded the old concepts as limited cases that were applicable solely to the familiar experiences of man.

In 1687 Newton formulated his Relativity Principle. He stated that mechanical laws valid in one place are equally valid in any other place moving uniformly relative to the first. This he illustrated by pointing out that a sailor on a ship moving through a sea can be eating a bowl of soup which will remain perfectly stationary as if the ship were at rest. Or if the waters outside are rough, the sailor still has no idea from within how fast or in what direction the ship is travelling.

The implication of this principle was far reaching. With confidence in the ultimate harmony of the universe, Newton believed that physical laws applicable on earth were actually universal laws as well. Thus the falling of an apple on earth is related to the whirling of the planets around the sun.

But there were many things Newton could not prove and about which he could only speculate. Although he could not prove that absolute

motion existed, he suggested that relative motion could probably be distinguished from absolute motion, and that somewhere there might be a body absolutely at rest.

Even more important was his view that space itself might be a fixed frame of reference to which the moving suns and galaxies could be related in terms of absolute motion. For to Newton, space was a physical reality, stationary and immovable. If this could not be demonstrated scientifically, then, in Newton's view, it would be demonstrated theologically, for space was the devine omnipresence of God in nature.

Thus the end product for the next two centuries was the provision of a mechanical model of nature, with an absolute and immovable space. In order to bear out Newton, scientists even created a new substance, ether, which they presumed filled Newtonian space.

By 1905, Albert Einstein began to change all of this. He wrote a paper rejecting the other theory[1] and the whole idea of space as a fixed system or framework absolutely at rest, by which absolute motion could be distinguished from relative motion.

---

[1]This he based upon the experiments of Michelson and Morley in 1881, by which they proposed to measure the earth's motion through the sea of ether like a sailor would measure a ship's velocity through water, namely casting out a log. In this case the log was a beam of light. By this, they demonstrated that the velocity of light remained unchanged and therefore no ether existed. This shook the basis of Newtonian assumptions which had stood for two hundred years.

To accomplish this, Einstein formulated his Special Theory of Relativity, which incorporates Newton's law that mechanical laws are the same for uniformly moving systems, but which also reaches beyond it. The laws governing light and other electromagnetic phenomena are added to Newton until a new postulate is formed: all the phenomena of nature and all the laws of nature are the same for all systems that move uniformly relative to one another.

Einstein ended Newton's hopes of an absolute somewhere by proving through deduction from examples the following: there is no absolute frame of reference, for all is in motion and relative to all else; space is simply an order or relation of things among themselves; time itself is relative, for it is determined by our perception of it;[2] there is nothing universally simultaneous, for events do not take place simultaneously in unrelated systems.

Einstein further changed the concept held by classical physics and Newton that mass[3] and energy are separate. Einstein showed that mass increases with velocity, until reaching an infinite state at the velocity of light. Motion is energy, and since mass increases with motion, mass and energy are equivalent. With the famous equation E=mc2, Einstein proved that energy has mass. Hence all is energy.

---

[2]Einstein proved that the top limiting velocity of the universe is light, and measurements of time and space, e.g., a measuring rod and a clock decrease in length and slow to a stop respectively as they approach the velocity of light.

[3]Mass to a physicist is resistance to a change in motion.

With Einstein's General Theory of Relativity, Newton's thories were further revealed as inadequate. The results achieved by Einstein were close to Newton, but the discoveries of new and more accurate details destroyed further Newtonian cosmology.

The springboard for Einstein's new theory was Newton's Law of Inertia stating "every body continues in its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed thereon." Further, Newton added that the amount of force necessary to accelerate a body depends on the mass of the body, and that if the same force is applied to two bodies of different masses, then there will be a greater acceleration in the smaller body. The exception to this is with falling objects. To explain this, Newton formulated the Law of Gravitation. He says that the force by which a material body attracts another body increases with the mass of the object it attracts. In other words, gravity is always exerted in just the necessary degree to overcome the inertia of any object, and they fall to the ground at the same rate.

Einstein could not accept Newton's assumptions that there was a balance of gravitation and inertia, and that gravitation is a force exerted over great distances.

Einstein began by again rejecting the absolute. In this case it was the absolute of non-uniform motion. By giving several examples of elevators falling through space and within the gravitational system of the earth, Einstein showed by his Principle of Equivalance of

Gravitation and Inertia that motion produced by inertia cannot be distinguished from motion produced by gravitational force. Therefore, the question of absolute motion, in this case, nonuniform motion (such as the jerk of a train) is not unique or absolute, and cannot provide means to distinguish effects.

Einstein further alters Newton by eliminating Newtonian concepts. Einstein's Law of Gravitation contains nothing about force. It does not describe the behavior of objects in terms of "attractions" as did Newton. But by probing deeper reality, it eliminates the machine-like qualities of Newton's concept. Planets and objects in a gravitational field are described in terms of the paths they follow. Gravitation is simply a part of inertia, for planets move as a result of their inertia and the courses they follow are determined by the metric properties of space. Just as Maxwell and Faraday assumed that a magnet affects the properties of surrounding space, so Einstein concluded that celestial objects do the same.[4]

This explained another phenomenon that Newton had been unable to explain, namely the deviation by the planet Mercury in its orbit. But

---

[4]The difference between Einstein and Newton has been pictured as that between two observers of a little boy playing marbles in a city lot. One observer (Newton) is ten stories above the lot and thinks that the marbles, moving mysteriously about and avoiding certain spots, are being affected by "forces." Yet the ground observer (Einstein) can see that the curvature of the lot accounts for their strange path.

once Mercury's high speed and the heat of the sun could be shown to affect the gravitational field rather than attraction and forces, the problem was solved.

According to Newton, light rays should always travel in a straight line. Yet Einstein proved, by photographing stars at night and then in the daytime (during an eclipse), that light rays curve when passing through a gravitational field.

Time as well as space is affected by the gravitational field, of which Newton understood only a part. A clock transported to the stronger gravitational field of the sun will run more slowly, and even the frequency of radiation is slower.

Newton had always held that the universe is not infinite, yet scientists following him doubted this. Einstein proved what Newton thought, but not with the same logic as Newton. Newton reasoned that were the universe infinite, the total gravitational forces would be infinite and the heavens would be illuminated by infinite light, as was not the case. Hence, the universe was not infinite.

Einstein found Newton's reasoning inadequate. Since his General Theory of Relativity showed that a gravitational field was shaped by the mass and velocity of a body, Einstein concluded that the structure of the universe is shaped by the sum of its material contents. Since the concentration is greater, the space-time continuum curves, and the result is a curvature of the universe.

The consequences of this again reach far beyond Newton. Einstein

thus showed that in the universe there are no straight lines, but only great circles. No longer would infinite straight lines run parallel forever. Space was finite, but unbounded.[5] Einstein was even able to compute the size of the universe, and computed the radius to be 35 billion light years.

Einstein's final theory, the Unified Field Theory, reached farther beyond Newton's world. Herein Einstein demonstrated that Quantum physics and Relativity are interdependent and inseparable. (re Planck)

Thus, the progression of science has greatly altered Isaac Newton. The discoveries of Newton, brilliant for his time, have not been proved false. But the work of another man, Albert Einstein, has carried these discoveries far from their original significance. Einstein has shown that Newton's hopes for an absolute somewhere cannot be fulfilled. Einstein has destroyed the cosmology resulting from Newton's discoveries. The universe can never again be viewed as a rigid and immutable edifice with independent matter orderly placed within independent space and time. Rather it can be seen only as an amorphous continuum, with no fixed structure, plastic and changing, constantly subject to distortion by the imperfect sense perception of man.

---

[5] Sir James Jeans describes the universe in terms of a soap bubble, wherein the universe is the surface, but with its four dimensions. Other scientists since Einstein have further proved the universe is not static, and that it is constantly expanding.

NEWTON	EINSTEIN
Similarities	
Faith in universal harmony	Faith in universal harmony
The universe is finite	The universe is finite
Laws and assumptions	
Mechanical laws are the same for all uniformly moving systems	<u>Special Theory</u>: all laws of nature are the same for all uniformly moving systems <u>General Theory</u>: all laws of nature are the same for all systems regardless of motion.
Law of Gravitation: a force by which one body attracts another increases with the mass of the body.	There is no force There is no attraction There is only a path created by the movement of the body.
Assumes for above theory that gravitation and inertia are balanced	They are not balanced. Gravitation is a part of inertia, or the field is created by the inertia of the moving planet.
Assumes that somewhere there is absolute stationery frame of reference in universe Some body is absolutely at rest somewhere.	There is none. Everything is in motion relative to everything else.
Assumes there is absolute motion	There is no absolute motion, including non-uniform motion.
Assumes space is stationary and immovable	Space constantly moving and changing.
Assumes space is filled	Space is only the relation of things to each other, and can be nothing

NEWTON	EINSTEIN

Laws and assumptions (Cont.)

Assumes universe is not infinite because there would be infinite gravity and light	Proves universe is not infinite, by showing that it is the sum total of matter, which could be computed.
Assumes energy and mass are separate	Energy and mass are interchangeable.
Assumes mass is a fixed and unchanging property . .	Mass increases with increased velocity

Methodology

Defined reality as he perceived it through the screen of his senses	Senses deceive. Only mathematical formulas describe behavior of phenomena, of which the eye sees inaccurately and a small portion at that.
Method was sense perception and deduction.	Method was example and deduction.

Concept of science in the universe

Science should answer how things happen	Science cannot explain how. Science can only say that certain things do happen.
Science illustrates cause and effect and determination	There is no cause and effect and there is no determination. There are only uncertainties and constant changes.

Cosmology

The universe is an unerring, manageable machine firmly rooted in definite space and definite time.	The universe is not a rigid and immutable edifice with independent matter in independent space and time but an amorphous continuum, plastic, constantly changing and subject to distortion.

Bibliography

Lincoln Barnett, The Universe and Dr. Einstein, Mentor Books, 1957.

A. S. Eddington, The Nature of the Physical World, Macmillan Company, 1932.

Albert Einstein and Leopold Infed, The Evolution of Physics, Simon and Schuster, 1942.

Albert Einstein, Relativity, the Special and General Theory, Henry Holt & Co., 1920.

Philipp Frank, Einstein, His Life and Times, Alfred A. Knopf, 1947

George Gamow, One Two Three . . . Infinity, Viking Press, 1947.

G. E. M. Jauncey, Modern Physics, Van Nostrand Company, 1948.

Sir James Jeans, The Mysterious Universe, Macmillan Company, 1932.

Sir James Jeans, Physics and Philosophy, Macmillan Company, 1943.

Hermann Weyl, Mind and Nature, Pennsylvania Press, 1934.

Alfred North Whitehead, Science and the Modern World, Macmillan Company, 1925.